

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**

**THIS PAGE BLANK (USPTO)**

PCT

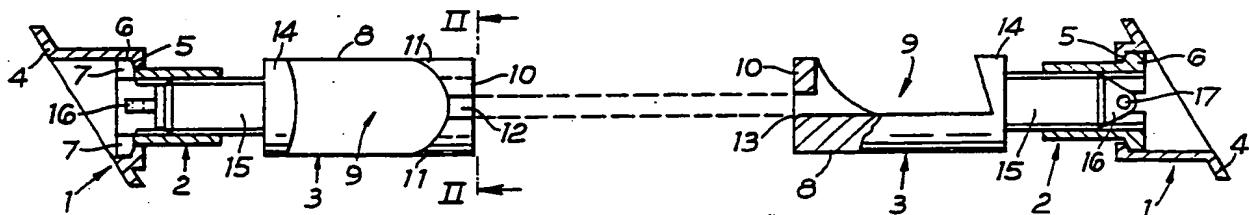
WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

D2

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :  A61F 2/08	A1	(11) International Publication Number: WO 92/02196  (43) International Publication Date: 20 February 1992 (20.02.92)
(21) International Application Number: PCT/GB91/01295		(81) Designated States: AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent), US.
(22) International Filing Date: 30 July 1991 (30.07.91)		
(30) Priority data: 9016761.0 31 July 1990 (31.07.90) GB		
(71)(72) Applicant and Inventor: JOHNSON, David, Paul [GB/GB]; Woodland Lodge, 69 Cleveland Road, Failand, Bristol BS8 3UL (GB).		Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(74) Agents: LAINE, Simon, James et al.; Wynne-Jones, Lainé & James, 22 Rodney Road, Cheltenham, Gloucestershire GL50 1JJ (GB).		

## (54) Title: IMPROVEMENTS RELATING TO SURGICAL DEVICES



## (57) Abstract

A screw tensioning device is proposed for holding at least one end of a ligament graft. The device has a thimble (1) which engages in the mouth of a drilling through bone, a nut (2) captively seated in the thimble, and an anchorage element (3) with a screw threaded stud (12) which can engage the nut. Different forms of element are provided for different grafts, but each is adapted securely to hold one end. The anchorage element (3) with ligament attached is drawn through the drilling from the opposite side to the thimble (1) until the stud (12) engages the nut (2). That is turned by a tool (19) until the required tension is achieved.

**FOR THE PURPOSES OF INFORMATION ONLY**

**Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.**

AT	Austria	ES	Spain	MC	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland	KR	Republic of Korea	SN	Senegal
CI	Côte d'Ivoire	LI	Liechtenstein	SU+	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TC	Togo
DE	Germany	MC	Monaco	US	United States of America

+ It is not yet known for which States of the former Soviet Union any designation of the Soviet Union has effect.

"Improvements relating to Surgical Devices"

This invention relates to surgical devices and is concerned with an adjustable tensioning assembly for ligaments.

5       The recent treatment of chronic knee instability due to rupture of the anterior cruciate ligament has been a mixture of ligament repair, augmentation or substitution by tendon transfer. The mediocre results and the inability of most athletes to return to their previous sporting activities in  
10      full capacity has prompted intense research into prosthetic cruciate replacement (Johnson RJ et al. 1984). Initial research centred upon the use of the patella tendon or tensor fascia larter. Subsequent research centred upon carbon fibre or dacron ligaments as scaffolds for the slow  
15      invasion by fibrous tissue (Butler DL et al 1985). Recently great interest has been shown in expanded polytetrafluoroethylene or "Gore-tex" ligaments. This ligament was first used in a multi centre research project in 1984 and the initial good results have resulted in its wider use. However, the  
20      long term results of independent assessment suggest an incidence of chronic knee effusion and late rupture of the Gore-tex graft. As a result, the most common technique at the present time is the use of an autogenous patella tendon graft with bone harvested from the patella and the tibial  
25      tuberosity. The patella tendon graft and bone plugs are fed into tunnels within the femur and tibia and secured at each end.

One of the outstanding problems and the subject of much

discussion is the isometric placement of these ligaments. Theoretically isometric placement is possible where the ligament remains at the same tension throughout the range of knee flexion. However, this is difficult to achieve in practice. Many recent projects have defined the isometric points for insertion of the drill and have demonstrated the effect of incorrect placement. However, an unsolved problem is the fixation of the ends of the ligament with sufficient strength for early motion to be allowed. Different techniques include screws, baffles, bone blocks, staples, washers, screws and more recently toggles (Amis AA 1988. Good et al 1988). These all provide support which may be unreliable and which usually require protection or cautious use for up to one year to allow adequate fibres or bony ingrowth to provide secure fixation. This delays the return to activity, particularly sports, which leads to more muscle wasting and stiffness.

The final problem, which has yet received little attention, is correct tensioning of the ligament. For the ligament to be functional it not only has to be inserted isometrically but it has to be correctly tensioned in order to allow a full range of motion. In particular, it needs to be tight enough to give stability rather than being a check rein loaded only at the extremes of motion. With some ligaments, such as the Leeds Keio ligament, maintenance of tension during insertion is technically difficult, and early reports suggest some degree of laxity is often present post-operatively. No method of insertion is believed to be

currently available such that the tension may be incrementally increased while the range of motion and stability is continuously examined.

The aim of this invention is to enable a ligament to  
5 be inserted and firmly held in position in an easy and certain manner, while allowing the tension in the ligament to be adjusted to an optimum. It may even be adjustable at a later operation if necessary. It should also be usable for a prosthetic ligament graft as well as an autogenous patella  
10 tendon graft.

According to the present invention there is provided a tensioning device for ligament grafts, the device comprising an anchorage element for receiving and holding one end of a ligament when it is under tension and leading from one end 15 of said element, a bone engaging thimble, and screw means located by the thimble and co-operating with said element at its other end for drawing said element and said thimble together.

To fit such a device the bone is drilled through and  
20 the anchorage element, with one end of the ligament engaged with it, is inserted through the bore from one side. The thimble is placed to abut the opposite side of the bone, having a portion which locates it partially within the other end of the bore. The screw means are then engaged and as  
25 they are tightened the ligament is tensioned and the thimble is drawn more firmly against the bone.

Usually, there will be a pair of such devices with the other end of the ligament anchored in a similar manner,

alth ugh screw-adjustability at both ends may not always be required.

In the preferred form, the thimble is generally of hollow cylindrical form having an external flange at one end and an internal shoulder at the other end, the flange being for abutment of bone around the mouth of a drilling in which the remainder of the device is received, and the shoulder being for retention of the screw means. The flange will generally be at a slant with respect to the axis of the cylinder, preferably in the range of 45° - 60° and the screw means will have an external projection for engagement of said internal shoulder of the thimble. The screw means may have a detent in its end for turning by a tool entered through the thimble, and conveniently it takes the form of a nut engageable on a threaded portion of said anchorage element.

The anchorage element will preferably be of generally cylindrical form co-axial with the screw means to fit snugly in the bore through the bone, but having a lateral recess to accept an end of the ligament. In one form a slot leads from said recess to said one to guide the ligament into leading substantially co-axially from said element, the portion in which the slot is formed providing an abutment for a bone fragment at the end of a harvested tendon. In another form, the recess has an upstanding abutment within the envelope of said element for the retention of the end of a prosthetic anterior cruciate graft.

For a better understanding of the invention one

embodiment will now be described, by way of example, with reference to the accompanying drawing, in which:

Figure 1 is a side view, partially in longitudinal section, of a ligament tensioning device,

5 Figure 2 is a section on the line II-II of Figure 1,

Figure 3 shows a lead wire for use with the device,

Figure 4 is a side view of a tensioning key for use with the device, and

Figure 5 shows views of an alternative carrier that  
10 could be incorporated in the device.

Reference will be made to inner and outer ends, these being with reference to the mid-point of the assembly.

At each end the tensioning device comprises a thimble 1 outermost, an intermediate nut 2, and a carrier 3 innermost. At the left hand end the carrier 3 is shown rotated through 90° from identical orientation with the carrier at the right hand end.

Each thimble 1 is of squat cylindrical form with its outer end angled and having an external flange 4. This angle 20 is preferably between 45° and 60° to the axis. Internally, the thimble has a thickened portion towards its inner end to form a shoulder 5.

Each nut 2 is basically a hot -w internally screw-threaded cylinder with an external rim 6 at its outer end, 25 the underside of which co-operates with the shoulder 5 of the associated thimble. At this end, diam trically opposite zones are cut away to form slots 7. At the inner end, there is an internal bevel to facilitate coupling to the carrier

3. The nuts 2 may be provided in various lengths.

Each carrier 3 has a main body 8 having a cylindrical envelope, but this has a middle portion cut away to form a recess 9. At its inner end, the wall 10 defining the limit 5 of the recess is shaped with re-inforcing shoulders 11 and is cut away in a T-shaped slot 12 as best seen in Figure 2. The cross arm of the T opens to the base of the recess 9 and is virtually diametral of the inner end of the carrier. Where it emerges to the end face, there is a rounded or 10 bevelled edge 13 to reduce chafe. At the outer end of the recess 9, the end wall 14 is undercut to contain the bone fragment. Beyond that there is a co-axial stud 15 externally threaded to mate with the nut 2. At its coned tip, which eases entry into the nut 2, the stud 12 has a trans- 15 verse lug 16 with a small hole 17.

For fitting this device the bone is drilled through with a bore corresponding to the envelope diameter of the carriers 3, which is the same as that of the non-flanged parts of the thimbles 1. A lead wire 18 is connected to one 20 of the carriers 3 using the hole 17. A suitable configuration for the wire 15 is shown in Figure 3. The long loop is then passed through the bore, and also through the nut 2 and thimble 1 which are lightly held in place at the other end of the bore. It can also be passed through a tensioning 25 key 19 (Figure 4) which is of hollow cylindrical form with a knurled portion 20 for a good grip, and two lugs 21 at one end to co-operate with the slots 7. The carrier 3, with a bone fragment located in the recess 9 and the attached

tendon 1 ading through the slot 12, is drawn up the bore until the stud 15 engages the nut 2, which can then be turned using the key 19 to complete the tensioning. Once that is done, the key can be removed, and then the lead wire  
5 18.

This assumes that the ligament is already anchored at the other end. If it is not, then of course there will be no tension and the nut is simply done up a number of turns to ensure a good grip, while allowing for later adjustment.

10 The alternative carrier of Figure 5 differs by having a bollard 22 upstanding in the recess 9 and inclining towards the stud end. The undercut at that end is not required and both end walls have generally the same configuration with the T-slot opened out into a square one 23.  
15 This bollard enables a prosthetic anterior cruciate graft to be coupled as an alternative to an autogenous patella tendon.

CLAIMS

1. A tensioning device for ligament grafts, the device comprising an anchorage element (3) for receiving and holding one end of a ligament when it is under tension and 5 leading from one end of said element, a bone-engaging thimble (1), and screw means (2) located by the thimble and co-operating with said element at its other end for drawing said element and said thimble together.

2. A device as claimed in Claim 1, characterised in 10 that the thimble (1) is generally of hollow cylindrical form having an external flange (4) at one end and an internal shoulder (5) at the other end, the flange (4) being for abutment of bone around the mouth of a drilling in which the remainder of the device is received, and the shoulder (5) 15 being for retention of the screw means (2).

3. A device as claimed in Claim 2, characterised in that the flange (4) is at a slant with respect to the axis of the thimble.

4. A device as claimed in Claim 2 or 3, characterised 20 in that the screw means (2) has an external projection (6) for engagement of said internal shoulder (4) of the thimble.

5. A device as claimed in Claim 2, 3 or 4, characterised in that the screw means (2) has a detent (7) in its end for turning by a tool (19) entered through the thimble (1).

25 6. A device as claimed in any preceding Claim, wherein the screw means (2) is a nut engageable on a threaded portion (15) of said anchorage element (3).

7. A device as claimed in any preceding Claim,

characterised in that the anchorage element (3) is of generally cylindrical form co-axial with the screw means (2) and has a lateral recess (9) to accept an end of the ligament.

5        8. A device as claimed in Claim 7, characterised in that a slot (12) leads from said recess (9) to said one end to guide the ligament into leading substantially co-axially from said element, the portion in which the slot is formed providing an abutment (10) for a bone fragment at the end of  
10      a harvested tendon.

9.        A device as claimed in Claim 7, characterised in that the recess (9) has an upstanding abutment (22) within the envelope of said element for the retention of the end of a prosthetic anterior cruciate graft.

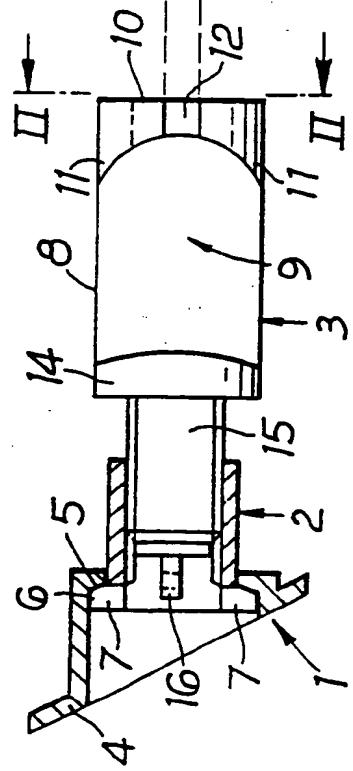


Fig. 1

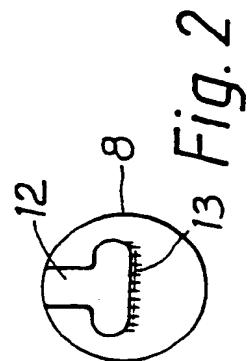


Fig. 2

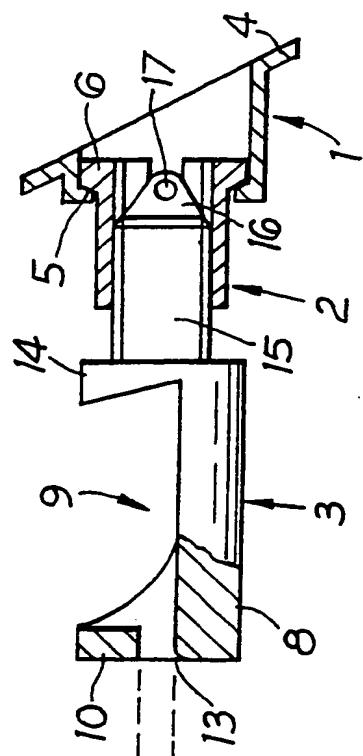


Fig. 1

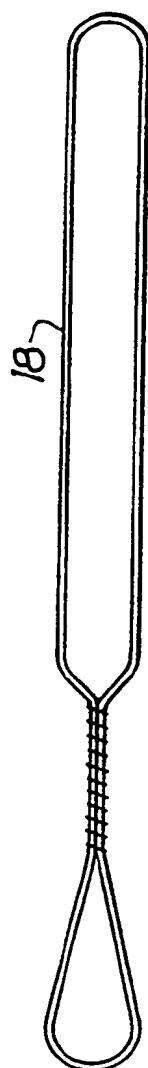


Fig. 3

1/1

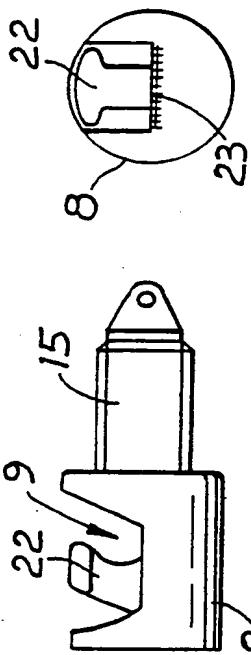


Fig. 4

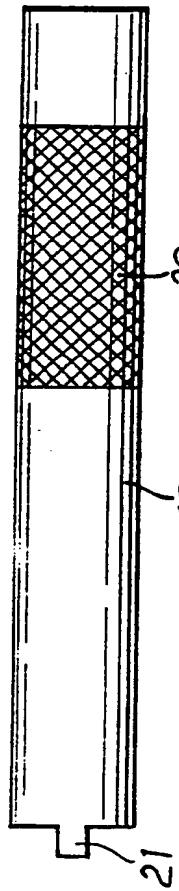


Fig. 5

## INTERNATIONAL SEARCH REPORT

PCT/GB 91/01295

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)<sup>6</sup>

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 A61F2/08

## II. FIELDS SEARCHED

Minimum Documentation Searched<sup>7</sup>

Classification System	Classification Symbols
Int.Cl. 5	A61F

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched<sup>8</sup>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup>

Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	FR,A,2 483 772 (RAMBERT) 11 December 1981 see page 5, line 15 - line 19; figure 3 ---	1,6
Y	EP,A,0 232 049 (PFIZER) 12 August 1987 see page 12, paragraph 2; figure 9 ---	2-5,7,8
Y	CH,A,267 810 (RUTSCHI) 1 July 1950 see page 2, line 37 - line 46; figure 4 ---	2-5
X	US,A,3 973 277 (SEMPLE) 10 August 1976 see abstract; figures 1,2 ---	1,7
Y	US,A,4 772 286 (GOBLE) 20 September 1988 ---	7,8
A	DE,U,8 809 612 (KARLSRUHE) 15 September 1988 ---	
A		

<sup>6</sup> Special categories of cited documents :<sup>10</sup>

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

<sup>7</sup> "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<sup>8</sup> "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step<sup>9</sup> "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.<sup>10</sup> "A" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

14 NOVEMBER 1991

Date of Mailing of this International Search Report

09 DEC 1991

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer

BARTON S.

**ANNEX TO THE INTERNATIONAL SEARCH REPORT**  
**ON INTERNATIONAL PATENT APPLICATION NO. GB 9101295**  
**SA 50109**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EPO file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 14/11/91

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
FR-A-2483772	11-12-81	None		
EP-A-0232049	12-08-87	US-A- 4708132 AU-B- 583972 AU-A- 6796687 CA-A- 1277453 DE-U- 8701123 JP-A- 62179454		24-11-87 11-05-89 13-08-87 11-12-90 02-04-87 06-08-87
CH-A-267810		None		
US-A-3973277	10-08-76	GB-A- 1465744		02-03-77
US-A-4772286	20-09-88	AU-B- 606949 AU-A- 1618288 EP-A- 0342281		21-02-91 16-11-89 23-11-89
DE-U-8809612	15-09-88	None		

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82